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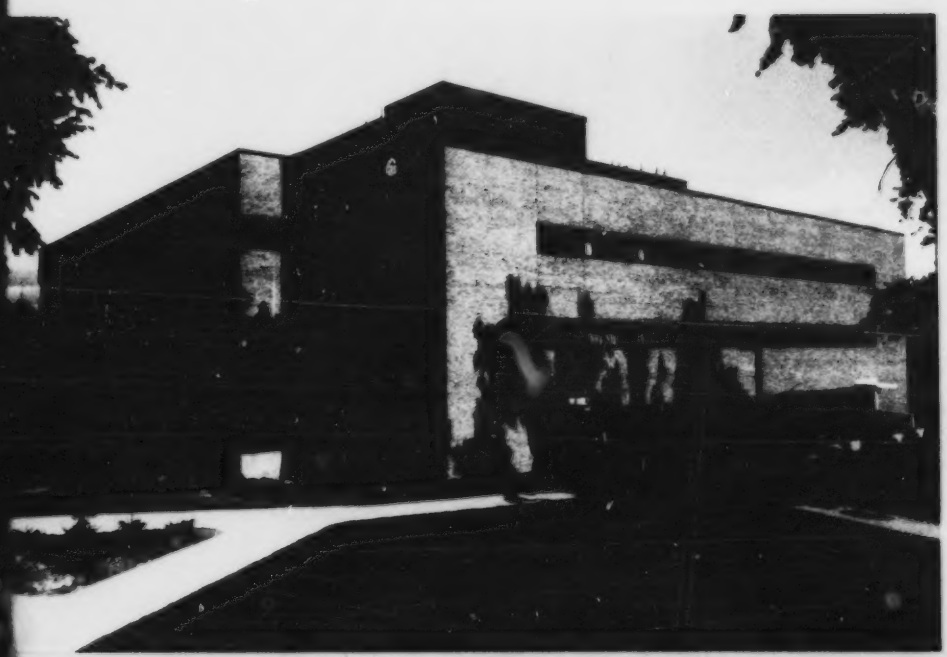
Program Review

1987~88

Great Lakes Forestry Centre



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PROGRAM REVIEW
GREAT LAKES FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
GOVERNMENT OF CANADA
1987-88

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THE CANADIAN FORESTRY SERVICE
GOVERNMENT OF CANADA

The Canadian Forestry Service is the main focus for forestry matters in the federal government. It provides national leadership through the development, coordination, and implementation of federal policies and programs to enhance the long-term economic, social, and environmental benefits that Canadians receive from the forestry sector.

The Service is a decentralized organization with six regional forestry centres, two national research institutes, and seven regional sub-offices located across Canada. Headquarters is located in the National Capital Region, in Hull, Quebec.

In support of its mandate, the Canadian Forestry Service carries out the following activities:

- undertakes and supports research, development, and technology transfer in forest management and utilization
- administers forestry development agreements negotiated with the provinces
- compiles, analyzes, and disseminates information about national and international forest resources and related matters
- monitors insect pests and diseases in Canada's forests
- provides information, analysis, and policy advice on economics, industry, markets, and trade related to the forestry sector
- promotes employment, education, and training opportunities in the forestry sector
- promotes public awareness of all aspects of the forestry sector.

The Service interacts regularly with provincial and territorial governments, industry, labor, universities, conservationists, and the public through such bodies as the Canadian Council of Forest Ministers, the Forest Sector Advisory Council of Canada, the Canadian Forest Inventory Committee, the Canadian Committee on Forest Fire Management, the Canadian Interagency Forest Fire Centre, and regional consultative committees. The Service is also active in international forestry agencies such as the International Union of Forestry Research Organizations, and the Food and Agriculture Organization of the United Nations, as well as in technical and trade missions.

SERVICE CANADIEN DES FORÊTS
GOUVERNEMENT DU CANADA

Le Service canadien des forêts est l'organisme principal en matière de foresterie à l'intérieur du gouvernement fédéral. Chef de file sur le plan national, il assure la préparation, la coordination et la mise en oeuvre des politiques et programmes fédéraux dans le but d'améliorer les avantages économiques, sociaux et environnementaux à long terme offerts aux Canadiens par le secteur forestier.

Le Service est une organisation décentralisée: six centres de foresterie régionaux, deux instituts de recherche nationaux ainsi que sept sous-bureaux régionaux sont repartis dans tout le Canada. Le siège social est établi dans la région de la Capitale nationale, à Hull (Québec).

Pour remplir son mandat, le Service canadien des forêts assume les tâches suivants:

. il entreprend et appuie la recherche, la mise au point et le transfert technologique dans le domaine de la gestion et de l'utilisation des forêts

. il administre les accords de développement forestier conclus avec les provinces

. il rassemble, analyse et diffuse de l'information sur les ressources forestières nationales et internationales et les domaines connexes

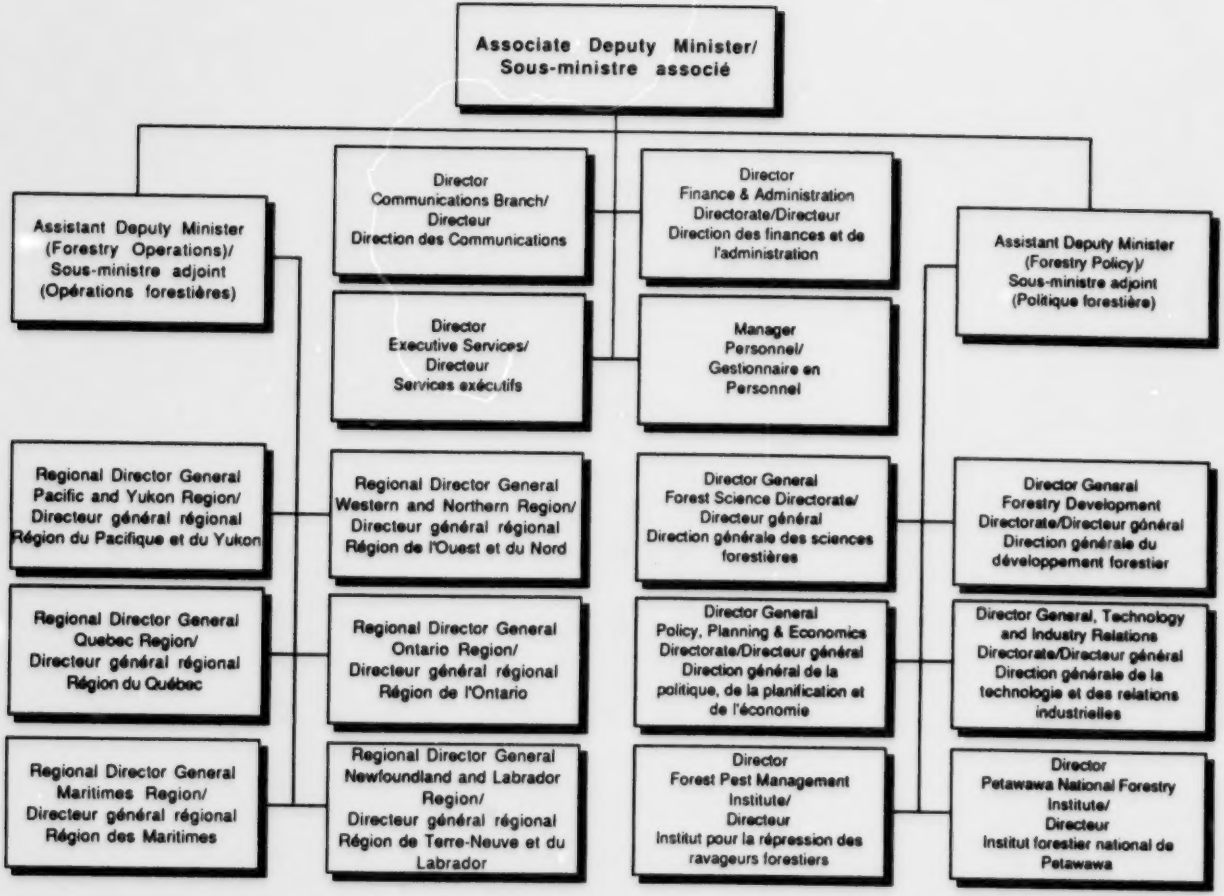
. il fait des relevés des insectes ravageurs et des maladies des forêts canadiennes

. il fournit de l'information, des analyses et des conseils (quant aux politiques) concernant l'économie, l'industrie, les marchés et le commerce reliés au secteur forestier

. il favorise les occasions d'emploi et de formation universitaire et technique dans le secteur forestier

. il encourage les Canadiens à prendre conscience de tous les aspects du secteur forestier.

Le Service entretient des rapports sur une base régulière avec les gouvernements provinciaux et territoriaux, l'industrie, le monde du travail, les universités, les environnementalistes et le public par l'entremise d'organismes comme le Conseil canadien des ministres des Forêts, le Conseil consultatif du secteur forestier, le Conseil consultatif de la recherche forestière du Canada, le Comité de l'inventaire des forêts du Canada, le Comité canadien de la gestion des incendies de forêt, le Centre interservices des feux de forêt du Canada et des comités consultatifs régionaux. Le Service joue également un rôle actif dans des organismes internationaux de foresterie comme l'Union internationale des organisations de recherche forestière et l'organisation pour l'alimentation et l'agriculture des Nations Unies, de même qu'au sein de délégations de nature technique ou commerciale.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FOREWORD

The Great Lakes Forestry Centre (GLFC), located in Sault Ste. Marie, Ontario, is one of six regional forestry centres operated by the Canadian Forestry Service (CFS). The CFS provides federal leadership and a national focus in the forestry sector for the continuing economic, social and environmental benefit of Canadians. The main activities of the CFS include research, development and technology transfer, forest resource development through federal-provincial forestry agreements, forestry sector data, trade and economics, promotion of the management of federal forest lands, international forestry, human resources planning and public awareness. GLFC is responsible for the CFS program in Ontario. This Program Review documents achievements in 1987-1988 and lists goals for the coming fiscal year.

Three Program Directors are responsible for managing our forestry programs. As a result of the retirement of J.H. Cayford, Director General, and C.R. Sullivan, Director of Research and Technical Services, and the resignation of M.J. Parent, Manager, Management Services, there was considerable turnover in GLFC's managment group in the past year. R.A. Haig is currently Acting Director General, and the Program Directors are T.J. Ennis, Research and Technical Services, L.F. Riley, Forest Resources and Environmental Forestry, and J.J. Farrell, Forestry Development (Acting). G.D. Huntley is Manager, Planning, Evaluation and Research Services, while D.W. Gair (formerly Finance Officer) has responsibility for Finance, Administrative Services and Facilities Management.

The research program deals directly with the issue of maintaining and enhancing the resource supply. Research is aimed primarily at increasing regeneration and reducing losses, but is also directed at increasing yields and improving utilization. In conjunction with this work, we are directing our research toward the maintenance of a quality environment. Activities range from basic to applied and developmental research and include a significant element of technology transfer. A Technology Transfer Specialist, appointed in the previous year, increased the level of activity in this area. However, technology transfer is a shared responsibility, and during the year, most members of staff participated in one way or another.

Numerous scientific and technical reports and papers were published during the fiscal year, including the Proceedings of the 1986 Canada-Ontario Joint Forestry Research Committee (COJFRC) symposium entitled: "Primeval improvement: the new forestry age". Presentations were made at several scientific meetings and conferences on such topics as entomology, pathology, forest fire research, atmospheric pollutants, site classification and silviculture.

Implementation and administration of the Canada-Ontario Forest Resource Development Agreement (COFRDA) was the major activity in forestry development during the past year. Participation in the National Forestry Statistics Program continued and work on a wood supply study was initiated as part of the National Forest Economics Research Program. Involvement with the Canada Employment and Immigration Commission declined as the forestry component of the Job Development Program was not renewed, and overall funding for the program decreased sharply.

Progress in the fourth year of COFRDA included regeneration of more than 36,000 ha, tending of nearly 14,000 ha, site preparation of 18,000 ha and the purchase of more than 39 million trees. Federal expenditures totalled $19.3 million, and through the use of a variable federal-provincial funding ratio, and the implementation of a comprehensive system of tracking cash flow, it was possible to achieve full utilization of available federal funds without overcommitment.

In October 1987 GLFC hosted the 14th session of the North American Forestry Commission. Major papers presented at that session will be published shortly as a joint report of GLFC and the Food and Agriculture Organization of the United Nations.

The Ontario Forestry Council (OFC) and the technical committee that supports it, the Ontario Forestry Research Committee (OFRC), which is the successor of COJFRC, consolidated their position as the coordinating body for forestry research in the province. OFRC prepared a list of forestry research priorities and invited GLFC, the Ontario Tree Improvement and Forest Biomass Institute, and the University of Toronto to indicate to what extent their current programs addressed these priorities. Meanwhile, the OFC commissioned a study on the management and coordination of forestry research, and the resulting Burgess Report recommended major changes in organizational structure. A final decision is pending. However, it seems likely that as a result of these developments, the forest industry will play a stronger role in the direction of forestry research, and it is hoped that the industry will become a major contributor to the funding of such research as well.

Continuing a tradition established under COJFRC, GLFC cooperated with the Ontario Ministry of Natural Resources (OMNR) in conducting the first annual symposium under the aegis of OFRC. The subject was "Taking stock: the role of nursery practice in forest renewal." As usual, the Proceedings were published by GLFC.

GLFC organized a study tour to the Iroquois Falls, Kapuskasing and Moosonee areas for a group of managers from the North Central Forest Experiment Station in St. Paul, Minnesota. The Centre also hosted annual liaison meetings with staff of the Faculty of Forestry at the University of Toronto and the School of Forestry at Lakehead University.

The GLFC work plan for 1988-1989 provides for a total of 170 person years. The increase of three person years over 1987-1988 reflects the fact that Personnel Services were recently incorporated into the Centre's work force.

In addition to the management changes noted earlier, there were several changes in personnel. M. Stone, senior storesman, died during the year; F.C. Stewart, construction coordinator, and M.K. Rouse, editorial clerk, retired; and J. Richenhaller, silviculture technician, J.J. Johnson, economist, G. Coutu, engineer, and L. Rouse, word processor operator, resigned. New appointments included those of D. McGregor, personnel advisor, A. Ghebremichael, economist, G.J.S. Hart, technical editor, K. Sears, engineer, and S. Melbourne, survey technician.

R.A. Haig
Acting Director General
Great Lakes Forestry Centre

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FOREST ENVIRONMENT RESEARCH

IMPACT OF LONG-RANGE TRANSPORT OF AIR POLLUTANTS ON THE BIOGEOCHEMISTRY OF FOREST ECOSYSTEMS

Professional Staff: N.W. Foster (Project Leader), G.D. Hogan, I.K. Morrison, J.A. Nicolson, R.D. Whitney

Support Staff: L.M. Chartrand, P.W. Hazlett, R.N. Irwin, A.W. Johns, D.J. Kurylo, D. Ropke

Objectives

To elucidate the influence of atmospheric deposition of acidifying substances on tree form and function, tree diseases, nutrient cycles and hydrologic processes in Ontario forests.

Achievements

Conducted the following experimental work: examination of nitrogen and sulfur mineralization in soil and factors affecting nitrification, denitrification studies with Turkey Lakes Watershed (TLW) soils in the field and laboratory, studies on fine root distribution and turnover and associated nutrient turnover at TLW, chemical analysis of vegetation and soil samples from eight jack pine sample plots, cooperative studies with Dr. Hutherman, University of Gottingen, Federal Republic of Germany, on physiological factors related to maple decline, and chemical analysis of vegetation and soils for an experiment on treatment of balsam fir with simulated acid rain; continued the following: streamflow and stream chemistry and collection of precipitation at 12 locations, sampling for snowmelt runoff study, chemical analysis of biomass-bioelements in the organic cycle at TLW, column-lysimeter experiment in the GLFC greenhouse.

Goals for 1988-1989

To remeasure 12 TLW permanent sample plots; to establish a fine-root ingrowth case study; to apply treatments in a nitrogen-phosphorus diagnostic fertilization experiment; to complete the synthesis of chemical and phytomass data from the Kirkwood jack pine study; to coordinate the Acid Rain National Early Warning System (ARNEWS) plant-

soil sampling and analysis program among regions; to continue the following: water sampling at TLW, field and laboratory studies on denitrification of soil, experiments relating to cation losses from soil, biogeochemistry initiatives in jack pine, column-lysimeter experiment in GLFC greenhouse, studies on the influence of simulated acid rain/drought interactions on the growth and physiological function of sugar maple, cooperative studies with Dr. Hutherman on physiological factors related to maple decline, studies on the influence of simulated acid rain on disease and mychorrizal development in balsam fir saplings.

FOREST PRODUCTION RESEARCH

BLACK SPRUCE ECOSYSTEM SILVICULTURE

Professional Staff: R.A. Sims (Project Leader), R.L. Fleming, A. Groot, V.F. Haavisto, J.K. Jeglum, B. Payandeh

Support Staff: M.J. Adams, G.T. Atkinson, D.S. Mossa, R.M. Siltanen, S.J. Taylor

Objectives

To develop classification systems for black spruce ecosystem types in Ontario for forest management purposes; to determine if modified cutting and direct seeding are feasible alternatives to clearcutting and planting for regenerating black spruce; to determine the feasibility of intensive treatments such as drainage, fertilization and thinning to increase productivity on black spruce peatlands; to determine the impact of forest management practices on black spruce ecosystems, and to develop ecologically sound management alternatives.

Achievements

Conducted pilot mapping and photo-interpretation studies in two areas for the North Central Region FEC; worked on an FEC-related plant identification field guide and held a series of FEC field courses; published a report on site damage on peatlands; analyzed growth and yield data for peatland black spruce and spruce-fir forest types using regression models; analyzed trees from a northeastern Ontario fertilization trial; established a black spruce outplanting study in the Wally Creek drainage area; studied groundwater hydrology and water quality, foliar chemistry, and vegetational change in the Wally Creek Drainage Area; published eight papers from the Nipigon Strip Cut Workshop; continued the following: data analysis for the Forest Ecosystem Classification (FEC) in the Clay Belt, a precommercial thinning trial and spacing trials, investigations of forest harvesting-advance growth relationships, investigations of direct seeding on upland and lowland sites, investigations of cone and seed production and conifer seed treatments to modify germination rates, investigations of blowdown and mortality caused by root rot.

Goals for 1988-1989

To provide input into the Wally Creek drainage project and monitor studies on hydrology, foliar analysis, and vegetational change in Wally Creek; to analyze data for the North Central and Northwestern Ontario FEC studies and complete field guides for publication; to continue the following: analysis and preparation of reports on studies of growth and yield, fertilization, drainage, precommercial thinning, and economic assessments of various regeneration options, advance growth studies, work on strip cutting technology transfer, work on upland and lowland seeding experiments, and investigations of cone and seed production.

BIOLOGICAL ASPECTS OF APPLIED SILVICULTURAL TECHNOLOGIES*

Professional Staff: C.R. Smith (Unit Head), J-D. Leblanc, B.J. Sutherland

Support Staff: F.F. Foreman, D.J. Kennington

Objectives

Through research, analysis of systems and development of methodologies: to evaluate and enhance applied silvicultural technologies in Canada; to foster the selection, application and development of biologically sound silvicultural devices and systems; to identify gaps in knowledge about the biological effects of applied silvicultural technologies and to communicate research needs to concerned agencies; to serve as the lead CFS agency and maintain liaison with other CFS agencies as well as with the Forestry Engineering Research Institute of Canada (FERIC), the provincial government, industry and other groups concerned with the biological effectiveness of applied silvicultural technologies.

Achievements

Published reports on the 10-year growth response and economics of commercial strip thinning of jack pine, evaluations of the Tetra tree-planter in Quebec, assessments of the Great Lakes Forest Products scarifier in Ontario and the Bräcke Mounder in British Columbia; established a long-term microsite comparison trial of disc trenchers in Saskatchewan in cooperation with CFS Prince Albert, the Saskatchewan government and Weyerhaeuser Canada; completed assessments of jack pine seedings on prescribed burns in Ontario; assisted Spruce Falls Power and Paper Ltd. in a preliminary seed deposition trial; cochaired the 1987 OFRC Symposium, chaired the Precommercial Thinning Working Group for Eastern Canada, and participated in various committees; discussed future project directions with staff of representative CFS, provincial and industrial agencies across Canada.

* Formerly Mechanization of Silviculture

Goals for 1989-1990

To prepare a manual of standard procedures for determining and evaluating seed dispersion characteristics of aerial seeding equipment; to continue the study of jack pine seeding on prescribed burns and report on seeding studies; to continue a microsite comparison trial on disc-trenched furrows in Saskatchewan; to draft a manual of operational guidelines for the tending and management of jack pine plantations; to assist OMNR in developing level II FEC management interpretations related to mechanical site preparation; to develop new study activities; to perform various liaison and technical service activities related to the biological aspects of applied silvicultural technologies.

REFORESTATION SILVICULTURE

Professional Staff:	F.W. von Althen (Project Leader), B. Payandeh, J.B. Scarratt, R.F. Sutton, J. E. Wood
Support Staff:	B.R. Canning, F.W. Curtis, D.L. Marles, E.G. Mitchell, T.P. Weldon

Objectives

To develop regeneration methods and associated tree growing techniques for efficient and effective stand establishment and treatment; to develop biologically sound techniques for the efficient and effective conduct of silviculture operations in Ontario.

Achievements

Prepared reports on the following: results of a black walnut/white pine plantation survey, remeasurements of permanent plots at the Rockland red pine plantation, the effects of site preparation and weed control on the survival and growth of black walnut, white ash, silver maple and hybrid poplar, three-year results of a mounding study with jack pine, the Containerized Tree Seedling Registry (2nd ed), root growth capacity and field performance of jack pine and black spruce, planting stock quality, spring planting and mechanization, and variation in water relations of black spruce stock types planted in Ontario; established thinning trial plots in naturally regenerated stands of yellow birch and sugar maple; continued the following: a study of the effects of intensive site preparation and weed control on the early growth of black and white spruces planted in a boreal mixedwood clearcut, investigation of the effects of weed control on the establishment of black spruce and jack pine and experiments to examine the efficacy of granular hexazinone applied in winter on shear-bladed strips in clearcuts of boreal mixedwood, and examinations of grade of container stock in relation to site type and planting season; analyzed data from mounding studies and old-field white spruce experiments; began a problem analysis of the boreal mixedwoods of Ontario; developed and calibrated forest regeneration models; developed the model "STOCK" for evaluation of stock production alternatives; evaluated residual field experiments and greenhouse experiments in container stock production and planting research; visited Sweden and Finland to study nursery and reforestation practices and research.

Goals for 1988-1989

To collect growth and yield data in hardwood afforestation studies and publish a report on the effect of weed control on black walnut survival and growth; to publish reports on factors affecting jack pine establishment; to continue the following: investigations of the effects of competition control on the survival and growth of black and white spruces planted in a boreal mixedwood clearcut, field assessments of a granular hexazinone study, field work on a metsulfuron methyl study, development of the boreal mixedwoods problem analysis, development of growth and survival submodels and the "PLANT PC" regeneration model, container planting experiments, fertilizer studies, overwintering experiments, and competition control and comparative planting studies; to complete reports on Bräcke mounding experiments; to prepare a paper on old-field white spruce experiments; to develop guidelines and objectives for a new study on the physiology of the major boreal tree species.

FOREST PROTECTION RESEARCH

FOREST FIRE RESEARCH

Professional Staff: B.J. Stocks (Unit Head), T.J. Lynham, D.J. M^{c}Rae

Support Staff: T.W. Blake, G.R. Hartley, J.A. Mason

Objectives

To coordinate GLFC fire research activities as part of Ontario's fire management program and participate in the CFS national program; to improve presuppression techniques by means of fuel-specific fire behavior models for major natural and cutover fuel types, by performance analysis and calibration of the Canadian Forest Fire Danger Rating System (CFFDRS) for Ontario conditions, and by improved fire prediction techniques; to develop guidelines for prescribed fire and wildfire, and to monitor their ecological effects on Ontario's forest ecosystems.

Achievements

Conducted four experimental fires in immature jack pine as part of a continuing investigation of fire growth from a point-source ignition; began to investigate the behavior and atmospheric impact of large-scale prescribed fires in Ontario as part of a multi-year study involving researchers from the CFS, the United States Forest Service (USFS), the National Aeronautics and Space Administration (NASA), and the Atmospheric Environment Service (AES); continued investigations of fire ecology; monitored and documented OMNR operational prescribed burns with emphasis on large-scale convection burns to gather mass fire behavior and methodology data; completed an analysis of fire weather, behavior, and occurrence for the northeastern area of the People's Republic of China, to determine the suitability of the CFFDRS for use in that country; continued to monitor and document fire behavior on selected Ontario wildfires to assist OMNR fire managers and to gather data for use in the Canadian Forest Fire Behavior Prediction (FBP) System; served in the CFS Fire Danger Group to develop the FBP System; served as chairman of the CFS delegation on the North American Forestry Commission Fire Management Study Group (Canada-U.S.-Mexico).

Goals for 1988-1989

To conduct a series of point-source and line ignition experimental fires in immature jack pine; to study in detail two large-scale prescribed burns in northeastern Ontario; to coordinate a cooperative effort of scientists from the CFS, the USFS, NASA, and AES to document the behavior and environmental impact of prescribed fires; to continue the following: participation in a CFS/Alberta Forest Service cooperative experimental burning project in northern Alberta, monitoring and documentation of fire weather and behavior on large Ontario wildfires, assessment of the impact of experimental fires, analysis of the performance of the CFFDRS in northeastern China and of fire weather and behavior associated with the large Chinese fire of 1987; to conduct a study of ignition rates and patterns, and their effect on erratic fire behavior and whirlwind development; to produce a photo series documenting and quantifying the fuel complexes in 300 Ontario forest stands sampled in 1987 under a COFRDA contract; to conduct training courses and engage in direct field consultation with OMNR fire and forest managers.

DEVELOPMENT AND APPLICATION OF CONCEPTS IN FOREST ENTOMOLOGY IN ONTARIO

Professional staff: D.R. Wallace (Project Leader), G.T. Harvey, D.B. Lyons, T.J. Lysyk, V.G. Nealis, C.J. Sanders

Support Staff: Z.M. Faux, S. Fera, G.S. Lucuik, D.L. Oliver, P.M. Roden

Objectives

To understand the processes that regulate insect populations; to provide information required by forest managers to cope with pest problems; to develop economically and environmentally acceptable methods of regulating forest pests; and to demonstrate the applicability of such methods to forest management in Ontario.

Achievements

Continued the following: operational monitoring of spruce budworm populations with pheromone traps; identification of the jack pine budworm pheromone and elaboration of the effects of pheromone blends and concentrations on mating behavior; collection and analysis of isozyme data for spruce budworm and other *Choristoneura* spp., and resolution of timing and other methodological problems in the transport of frozen moths for isozyme analysis; cooperative isozyme studies on strains of *Entomophaga* fungus, *Neodiprion* and *Conophthorus* spp., and on insect tissue culture cell lines; biennial bird census at Black Sturgeon Lake in relation to budworm population density and changes in stand structure; studies of carpenter ant predation on budworms, diurnal emigration of spruce budworm moths, biological control of gypsy moth with the European parasitoid *Ceranthia samarensis*, and egg parasitism of gypsy moth; completed the following: a model to time spray programs so as to conserve larval parasites of jack pine budworm; modeling of spruce budworm phenology and the life history of jack pine budworm; phenology and biometeorology of pine false webworm (Ph.D. thesis, U.B.C.); developmental model of field-collected eggs of gypsy moth; literature review on the effects of acid precipitation on the genera *Operophtera* and *Malacosoma* to direct future research; development of sampling methods for parasites overwintering in budworms including jack pine budworm and its parasitoids; growth studies of healthy and parasitized jack pine budworm; guidelines for timing

sampling and pest control programs; relationships between parasites and pathogens of budworms; the triennial project review; larch sawfly cocoons collected at Sault Ste. Marie airport to test for the presence of the parasite *Olesicampe benefactor*.

Goals for 1988-1989

To do the following: coordinate the Canadian/American cooperative spruce budworm pheromone monitoring system; incorporate trap and live performance results into a Geographical Information System; develop a working group (CFS, university, others) to direct pheromone research and application; identify the jack pine budworm sex pheromone; complete wind tunnel experiments on the effects of spruce budworm pheromone mixtures and concentrations and initiate field trials; study physical characteristics of dispersing spruce budworm adults and relationships between dispersal and trap catches; complete studies of dispersing moths in relation to time and temperature; begin a study of dispersal from low-density populations; undertake data analysis, interpretation and reporting on survivorship, population quality and population dynamics studies; model the effects of bark and bud microclimate on habitat temperature and pre-emergence development of budworm; test estimates of stage-specific survival rates with a budworm life history model; estimate parasitoid impact by a study of parasitoid biology; develop a time-series model for forecasting degree-day accumulations; model adult survival/ oviposition to clarify the relationship of abiotic factors and the egg:moth ratio; corroborate 1987 findings on carpenter ant predation; continue biennial bird census; initiate new bird exclusion and foraging studies; publish papers on developmental stages of pine false webworm; study further the development and behavior of gypsy moth and its parasitoids, and develop a phenological model of the synchrony of egg hatch with parasite life cycles; study effects of meteorological variables on larval behavior; begin study of effects of acid precipitation on defoliators; study spruce budworm survivorship to diagnose and identify natural mortality factors; study larval and pupal parasitoids and their alternative hosts; study European parasitoids of jack pine and spruce budworms as a means of biological control and develop parasitoid rearing methods; continue research on *Ceranthia* and gypsy moth (field research in Europe proposed to collect more live material and information on the parasitoid); undertake field work in Canada to develop a data base for use in planning parasitoid releases; complete papers on *Trichogramma minutum* research; complete volumes on "Control of Forest Insects in Canada" (J. Armstrong, Ed.); complete rearing of larch sawfly material and publish data on relocation of the *Olesicampe* parasite; develop production methods for host eggs for propagation of *Trichogramma;* initiate staffing action for the vice-Lysyk population dynamicist position.

FOREST PATHOLOGY RESEARCH

Professional Staff: J.T. Basham (Project Leader), M.T. Dumas, S. Takai, R.D. Whitney

Support Staff: W.E. Britnell, R.N. Irwin, W.C. Richards

Objectives

To develop silvicultural and management procedures and biological control methods to minimize the impact of root rot, stem decay and stem deterioration on the forests of Ontario; to determine relationships among various fungi causing butt and root rot in commercially important tree species; to exploit past research on Dutch elm disease by using developed technology to regulate toxin production and pathogenicity in canker, dieback and wilt diseases.

Achievements

Submitted for publication a comprehensive report on root rot damage in Ontario conifers; developed a method employing gas chromatography to monitor production of oxalic acid in various species and strains of *Armillaria;* in collaboration with M. Hubbes of the University of Toronto, determined that the isozymes of esterases and the soluble protein patterns could delineate different biological species of *Armillaria* and their clones; tested all *Trichoderma* species and strains for their ability to penetrate and kill *Armillaria* rhizomorphs; tested soil microbes known to be inhibitory to decay fungi against two important nursery diseases, *Rhizoctonia solani* and *Cylindrocladium floridanum,* with substantial success; continued mass production of cerato-ulmin (CU) to support local research and that of outside collaborators; with J. Nordin of the University of Massachusetts, completed evaluation of CU production by F_1 progenies from crossing between aggressive and non-aggressive *C. ulmi* parents; with M. Yaguchi of the National Research Council (NRC) in Ottawa, completed amino-acid sequencing; with V. Seligny of NRC, continued molecular cloning with CU for CU production; with R. Jeng of the University of Toronto, continued immuno-electron microscope localization within *C. ulmi* cells; with H. Otani of Tottori University in Japan, who was at GLFC as part of a bilateral exchange program, carried out an extensive study on elm/CU interaction; initiated integrated structural study of CU at NRC and the University of Saskatchewan; sampled aspen trees in a stand in the Thunder Bay region

that had been subjected to scarification at age 5, to determine the long-term effects of scarification on the extent of stem decay and stain, and to study the development of stem and root decay associated with scarification wounds.

Goals for 1988-1989

To publish a number of manuscripts by retiring scientists R.D. Whitney and J.T. Basham; in cooperation with OMNR scientists J. Juzwik and A.G. Gordon, to apply chemicals experimentally to trees in spruce plantations for control of *Armillaria* root rot; to apply fungicides directly to *Inonotus tomentosus* sporophores in an attempt to control tomentosus root rot in older spruce plantations; to continue the following: collaborative studies on CU and *C. ulmi;* work on host specificity of wood decay by *Armillaria obscura* isolates; determination of the amount of oxalic acid produced by different *Armillaria* species and isolates, and of its role in the infection process; testing of methods for introducing immunizing commensals into seeds and seedlings and soil microbes into soil; to initiate a study on the biosynthesis of CU by *C. ulmi;* to attend the 5th International Congress of Plant Pathology in Kyoto, Japan and present two invited papers; to chair a session of the Silver Jubilee International Symposium on Host-specific Toxin in Tottori, Japan and present an invited paper; to present a paper on oxalic acid production by *Armillaria* at the 7th IUFRO Conference on Root and Butt Rots.

FOREST UTILIZATION RESEARCH

ENERGY FROM FOREST BIOMASS

Professional Staff: B.J. Sutherland (Project Leader), J.K. Jeglum

Support Staff: F.F. Foreman

Objectives

To study the effects of forest land drainage on peat geochemistry, subsidence and water quality and on the production of biomass from wetlands in northeastern Ontario; to transfer to potential users the technology developed thus far.

Achievements

Continued the contract entitled "Cost Analysis of Producing Hog Fuel Using Two Systems: The Logging Residue Processor and the Crabe Combine Brush Harvester", and submitted a summary of work completed; developed an interactive computer equation/model for each harvesting system; continued to monitor the effects of forest land drainage on peat geochemistry and water quality and quantity in the Wally Creek drainage area; initiated contract research to address hydrological questions related to forest drainage in black spruce ecosystems; submitted a final report and a paper on water profiles for an international symposium on hydrology in Finland.

Goals for 1988-1989

To continue to transfer the technology developed under past ENFOR contracts by providing information to potential users; to submit the final report on the study entitled "Cost Analysis of Producing Hog Fuel Using Two Systems: The Logging Residue Processor and the Crabe Combine Brush Harvester".

FORESTRY SERVICES

FOREST INSECT AND DISEASE SURVEY

Professional Staff: G.M. Howse (Unit Head), H.L. Gross, J.H. Meating, D.T. Myren, K.L. Nystrom, D.B. Roden, P.D. Syme

Support Staff: M.J. Applejohn, W.D. Biggs, H. Brodersen, D.C. Constable, E.J. Czerwinski, C.N. Davis, H.J. Evans, C. Handfield, W.A. Ingram, V. Jansons, A. Johnston, C.G. Jones, A.J. Keizer, H.D. Lawrence, L.S. MacLeod, R.K. McCron, S. Melbourne, S.G. Payne, R.J. Sajan, B.E. Smith

Objectives

To provide information on the kind, severity, extent and impact of forest insect and disease problems in Ontario; to provide forest managers with information needed for decision-making on control operations; to advise and assist the province in planning and evaluating control operations; to improve procedures used in insect and disease surveys and assessments; to elucidate the bionomics of little-known forest pests.

Achievements

Conducted surveys to detect, identify, map, and estimate the impact of important forest pests; identified 3,800 insect and 1,500 disease samples in the laboratory; made 2,200 extension contacts; conducted special surveys of pest problems in plantations, seed orchards, seed production areas, provincial and national parks, and high-value commercial timber stands; conducted surveys with pheromone traps for spruce budworm, gypsy moth, oak leaf shredder and black army cutworm; monitored 27 ARNEWS plots and collected soil samples for chemical analysis; established and evaluated 1,750 sugar maple trees in 70 plots; assessed provincial spraying operations against spruce budworm on 76,819 ha, against jack pine budworm on 105,463 ha, and against gypsy moth on 40,249 ha; participated in the annual Forest Pest Reviews; through the signing of a Memorandum of Understanding with OMNR, elucidated the provincial and federal roles in forest insect and disease survey.

Goals for 1988-1989

To conduct surveys of, and report on, major forest pest problems in Ontario; to conduct special surveys as required; to monitor impact plots for spruce budworm, jack pine budworm and gypsy moth damage; to identify causes of disease in plant material submitted for assessment; to maintain the herbarium and complete the preparation of a catalogue of the plant collection; to continue intensive surveys to detect the presence of the European race of *Scleroderris* disease in southern Ontario; to monitor ARNEWS plots; to collaborate with provincial forest authorities and the Forest Pest Management Institute (FPMI) in developing forest pest control strategies and to evaluate their effectiveness; to review and improve insect and damage sampling methods.

FORESTRY SECTOR DATA

Professional Staff: J.H. Smyth (Project Leader)

Support Staff: K.L. Campbell

Objectives

To provide forestry information and related statistical information required by the federal government at both the national and the regional levels in the planning and execution of forestry-related obligations and commitments.

Achievements

Served as Chairman, FORSTATS Committee; published Selected Forestry Statistics, Ontario, 1986; updated and maintained a computerized forestry sector statistical data base for Ontario; prepared jointly with the Canadian Pulp and Paper Association a report on public forest management expenditures in Canada for the period 1984-1986; prepared and distributed four issues of Selected Economic Indicators, Forestry Sector, Ontario; conducted a bimonthly survey of the Ontario sawmilling industry for monitoring the impact of the lumber export tax on employment levels.

Goals for 1988-1989

To continue as Chairman, FORSTATS Committee; to update and maintain the computerized forestry sector statistical data base for Ontario; to publish Forest Management Expenditures in Canada, 1983/84-1984/85, in cooperation with the Canadian Pulp and Paper Association; to prepare and distribute four issues of Selected Economic Indicators, Forestry Sector, Ontario; to compile data on forest tree production centers in Canada from 1985 to the present.

LIAISON, DEVELOPMENT AND TECHNICAL SERVICES

Professional Staff:	C.R Smith (Project Leader), J-D. Leblanc, B.J. Sutherland
Support Staff:	F.W. Curtis, F.F. Foreman, S.J. Kennington, J. Richenhaller (1987)

Objectives

To undertake, on behalf of the Centre, activities not directly related to existing forestry or environmental programs; to provide advisory, operational and technical support services to research staff and other agencies.

Achievements

Continued to manage the balsam fir Christmas tree plantation study; exhibited a display at the Royal Winter Fair in cooperation with the Christmas Tree Growers Association of Ontario Inc.; continued forest management advisory services to CFB Borden; conducted a timber sale of plantation thinnings, a jack pine clearcut, and an operational cruise under contract; continued to maintain and operate the forest ecology trail; continued to maintain and develop the GLFC arboretum; supervised the contract for the local elm injection program; maintained liaison with industrial and provincial forest managers and with other elements of the provincial and federal governments.

Goals for 1988-1989

To continue the following: provision of forest management advisory services to CFB Borden, operation of the forest ecology trail, development and maintenance of the arboretum, and maintenance of the balsam fir Christmas tree plantation; to supervise a contract for improving the forest ecology trail; to administer the local elm injection program; to provide advisory and technical services to research staff and to other forestry agencies as required; to attend the annual meeting and field day of the Christmas Tree Growers Association of Ontario Inc. and with the same association to cosponsor a display at the Royal Agricultural Winter Fair.

ECONOMIC STUDIES AND DEVELOPMENT

Professional Staff: J.H. Smyth (Project Leader), S. Andersen, A. Ghebremichael

Support Staff: A.J. Brownwright, K.L. Campbell

Objectives

To study the economic aspects of forest management and industry issues; to provide economic input into program evaluation at GLFC and elsewhere in the CFS; to provide an economic perspective in the administration, implementation, and evaluation of federal/provincial forestry agreements; to undertake economic studies in forestry-related job creation programs and in support of the CFS National Forest Economics Program; to provide input into federal policy initiatives in forest management and forest industry development; to provide advice to other federal departments, provincial government agencies, and the forest industry on programs concerned with forest management or forest industry development.

Achievements

Conducted economic studies and analyses of major forest resource issues in Ontario; served as scientific authority for studies contracted under COFRDA; served on the Management, Technical Advisory and Evaluation committees of COFRDA; participated in the Forest Pest Losses Working Group of OFRC; represented Canada on the International Energy Agency/ Bioenergy Agreement (IEA/BA).

Goals for 1988-1989

To continue the activities outlined above and to represent the federal government in the negotiation of a new forest resource development agreement with the province of Ontario.

FORESTRY DEVELOPMENT

DEVELOPMENT AGREEMENTS

Professional Staff: J.J. Farrell (Project Leader), A.J.F. Ballak, R.M. Greet, R.L. Macnaughton, H.L. Jääskeläinen, W.B. Wiltshire

Objectives

To cooperate with OMNR in the administration of Canada-Ontario forestry agreements and to monitor and record progress and expenditures; to ensure federal participation and visibility in the public relations activities related to these agreements.

Achievements

Completed the Forest Management Subsidiary Agreement (FMSA) with the receipt of a final audit credit from OMNR; under the Canada-Ontario Forest Resource Development Agreement (COFRDA) regenerated over 36,000 ha of land, tended nearly 14,000 ha, site prepared over 18,000 ha, and purchased over 39.0 million trees; through an amendment to COFRDA allocated an additional $0.5 million for research and development, almost all of which is now committed to projects; made over 260 field visits, viewing all direct-delivery projects and sampling one activity per district for cost-shared projects; committed funding for the production of nearly 45 signs for the field signage program; published one issue of the COFRDA newsletter and the COFRDA mid-term report; presented a COFRDA display at professional and public gatherings; initiated preliminary discussions with Ontario concerning a new federal-provincial forestry agreement.

Goals for 1988-1989

To continue administration of COFRDA; to ensure federal participation and visibility in public information activities related to COFRDA; to plan for a new Canada-Ontario agreement to replace COFRDA when it expires; to assist with the review and/or development of federal forestry initiatives as required; to develop a framework for a final COFRDA evaluation that will begin in 1988.

EMPLOYMENT STIMULATION

Professional Staff: J.J. Farrell (Project Leader), A.J.F. Ballak, R.M. Greet, R.L. Macnaughton, H.L. Jääskeläinen, W.B. Wiltshire

Objectives

To provide job opportunities in the forestry sector, or assist in their provision, through projects that will enhance the skills of the participants and produce long-term forest management benefits.

Achievements

Completed a report on productivity in the Job Development Program; assisted the Canada Employment and Immigration Commission (CEIC) in proposal review and served on the UIC-Sec.38 Forestry Task Force; provided GLFC's research program with the equivalent of 5.3 PYs by accessing existing federal and/or provincial job stimulation and training programs.

Goals for 1988-1989

To continue to access available job creation programs to enhance the research capability of the CFS in the region; to participate as required in the administration of forestry job creation programs; to assist CFS headquarters in the development of forestry labor force statistics for the Ontario Region.

ADMINISTRATION, FINANCIAL SERVICES AND PROPERTY MANAGEMENT

ADMINISTRATION, FINANCIAL SERVICES AND PROPERTY MANAGEMENT

Professional Staff:	M.J. Parent (1987), D.W. Gair (1988), Regional Manager, Management Services
Support Staff:	C. Bodley, W. Borland, Y. Chartrand, W. Clarke, L. Cormier, D. Evoy, J. Graham, R. Graham, J. Heatley, A. Jones, J. Kimball, J. Lang, C. Lewis, J. Longo, J. Logtenberg, B. MacKay, B. McBain, G. McLeod, M. Mills, R. Moffatt, E. Morningstar, C. Novick, J. Novick, K. Pelletier, M. Pinder, D. Reid, L. Rouse (1987), M. Skouris, D. Sloan, B. Smith, M. Stone (1987), J. Theriault, D. Weeks, A. Zurby

Objectives

To provide administrative, financial and engineering services to GLFC in support of all programs and activities.

Achievements

Completed a stores inventory; partially implemented the Materiel Management Information System (MMIS); provided liaison between union and management on the Safety Committee; finalized a lease with OMNR for land on which to construct a provincial forest research center; negotiated and implemented a rental agreement with OMNR for accommodation at GLFC until the new provincial center is ready for occupancy; implemented a no smoking policy; completed an in-depth financial review of operating funds; completed a number of construction projects, including modernization of laboratories and insect rearing rooms to meet research requirements and renovations to accommodate a new scanning electron microscope.

Goals for 1988-1989

To review all inventories at GLFC and incorporate data into MMIS; to continue personnel development through training; to continue computerization of financial information; to carry out a number of engineering projects to repair and upgrade facilities and implement energy conservation measures.

BIOMETRICS AND APPLIED SOFTWARE SERVICE AND COMPUTING FACILITIES AND SERVICES

BIOMETRICS AND APPLIED SOFTWARE SERVICE AND COMPUTING FACILITIES AND SERVICES

Professional Staff:	N.I. Bailey, D.W. Beilhartz (Supervisor, Biometrics), J.E. Field (Supervisor, Computing Facilities)
Support Staff:	D.M. Grave

Objectives

To provide consulting services in experimental design, statistical data analysis, software use and computer applications; to promote the use of automated systems in research, administration and management to improve the efficiency of operations; to provide training in all aspects of computer use; to manage and maintain the in-house computer system.

Achievements

Upgraded the VAX 8500 computer system to a VAX 8530 and expanded capabilities and system resources; acquired and upgraded microcomputer resources to meet the Centre's needs; continued to provide management, operation and maintenance of computer and communications facilities; provided technical support to users; provided consultation services in software use, computer applications, data manipulation and transfer, personal computer use, experimental design, data analysis and statistics; conducted training sessions in basic WPS word processing for over 60 staff members.

Goals for 1988-1989

To expand resources in the VAX 8530 computer system; to increase the availability of computer terminals, microcomputers, and laser printers to staff through new acquisitions; to install newly acquired system management software packages, and to update current software packages; to acquire and install equipment for interfacing laboratory microcomputer systems with other work stations; to coordinate the acquisition, installation and development of an in-house electronic publishing system; to provide staff training in computer applications; to continue to provide the following: planning, management, operation and maintenance of computer and data communications facilities; advice on the capabilities and operation of facilities; consultation on the use of software packages, and on application development, data manipulation and data analysis and statistics.

RESEARCH AND TECHNICAL SUPPORT SERVICES

RESEARCH AND TECHNICAL SUPPORT SERVICES

Staff: M.F. Laporte (Greenhouse Technician), J.R. Ramakers (Chemical Analysis Laboratory Technician), E.R. Rayner (Photographer), G.K.M. Smith (Technology Transfer Specialist)

Objectives

To provide efficient and economical research and technical support services to GLFC.

Achievements

Performed 29,654 analyses on 3,114 plant tissue, soil and water samples; began using the Jarrell Ash Inductively Coupled Plasma Emission Spectrometer (ICP); provided staff with photographic services; prepared photographic and display material for a variety of meetings; maintained greenhouse services and provided technical assistance and advice to those conducting greenhouse and associated outdoor experiments; grew coniferous containerized planting stock for use in the field programs of various project groups; completed an analysis of technology transfer activity at GLFC and a framework for technology transfer at the Centre; wrote articles for popular forestry magazines and for the GLFC Forestry Newsletter; produced slide presentations; organized two forest management field tours involving scientists and industry foresters.

Goals for 1988-1989

To provide a full range of inorganic analytical service; to develop a wet-oxidation procedure as a general replacement for the present dry-ashing procedure in plant tissue analysis; to maintain quality control of chemical analyses; to provide photographic and video services to staff; to provide greenhouse services to research staff; to identify opportunities for technology transfer activities through liaison with project staff and clients; to continue to write articles for popular forestry magazines and for the Forestry Newsletter; to produce slide and video productions, concise summaries of research results, posters and displays; to assist with the organization of meetings.

COMMUNICATIONS SERVICES

COMMUNICATIONS SERVICES

Professional Staff: C.A. Plexman (Chief), S.B. Burt, G.J.S. Hart

Support Staff: N.J. Dukes, P. Jakibchuk, P. Sikorski

Objectives

To publish and disseminate scientific and technical information issuing from GLFC's research program in response to the needs of provincial and industrial forest managers; to promote an understanding of the wise use of forest resources among the general public; to promote the research and development activities of GLFC among all sectors of the public; to maintain library services that meet the changing needs of GLFC and FPMI.

Achievements

Published four issues of the Forestry Newsletter and produced four lists of recent publications; published three issues of the Survey Bulletin; produced a new brochure outlining the Centre's research and development program; published and distributed "Who's Who at the Great Lakes Forestry Centre 1987" and the 1986-87 Program Review; produced the latest five-year bibliography of GLFC publications, covering the years 1983-1987; undertook production of three major symposium proceedings; published four reports in the FIDS historical report series; assisted in the editing and production of a major booklet on root rot published through the Canada-Ontario Forest Resource Development Agreement; attended the International Technical Communications Conference in Denver; filled the newly created position of Technical Editor; streamlined record-keeping processes on the computer; prepared a publications plan for fiscal years 1988-1989 for CFS headquarters; distributed nearly 80,000 publications; used the MacIntosh computer graphics work station to provide camera-ready copy for key publications; reorganized the library storage collections and established a high-use storage area; completed a journal subscription review through the Library Advisors' Group; implemented online ordering procedures to improve efficiency in ordering books; trained library staff in the Dialog system of online searches; acquired and began using the Sydney Library Automated System, began staff training on the system, and closed the card catalogue as all new acquisitions were entered in the online catalogue.

Goals for 1988-1989

To publish four issues of the Forestry Newsletter and lists of publications as required, three issues of the Survey Bulletin, the 1987-88 Program Review, the 1987 OFRC symposium proceedings, papers presented at the 1987 North American Forestry Commission meeting, and symposium proceedings for the International Union of Forestry Research Organizations (IUFRO); to continue to develop skills in the use of computer graphics; to install electronic publishing equipment and begin to train staff in its operation; to publish Information Reports, Joint Reports and Miscellaneous Reports as required, and to edit and submit papers to scientific journals; to streamline more editorial procedures on the computer; to assist in the preparation of a history of forestry in Sault Ste. Marie; to recommend and explore new library services in response to staff needs; to complete training in the use of the Sydney Automated Library System; to conduct a journal subscription review in conjunction with the Library Advisors' Group; to prepare a Sydney presentation for GLFC/FPMI management; to prepare online search seminars, an orientation program and a users' guide to Sydney; to investigate the feasibility and costs of doing online conversion of cataloguing records as part of the retrospective conversion of the Library collection; to inventory Library storage areas; to implement the Sydney circulation and serials modules.

PERSONNEL SERVICES

PERSONNEL SERVICES

Professional Staff: D. McGregor

Support Staff: G. Thorpe, J. Viola

Objectives

To provide complete personnel administration services to management in the following areas: classification, staffing, compensation, staff relations, human resources planning, training and development; to provide managers with advice and guidance to ensure effective personnel management decisions that conform to departmental policy requirements and meet regional operational needs.

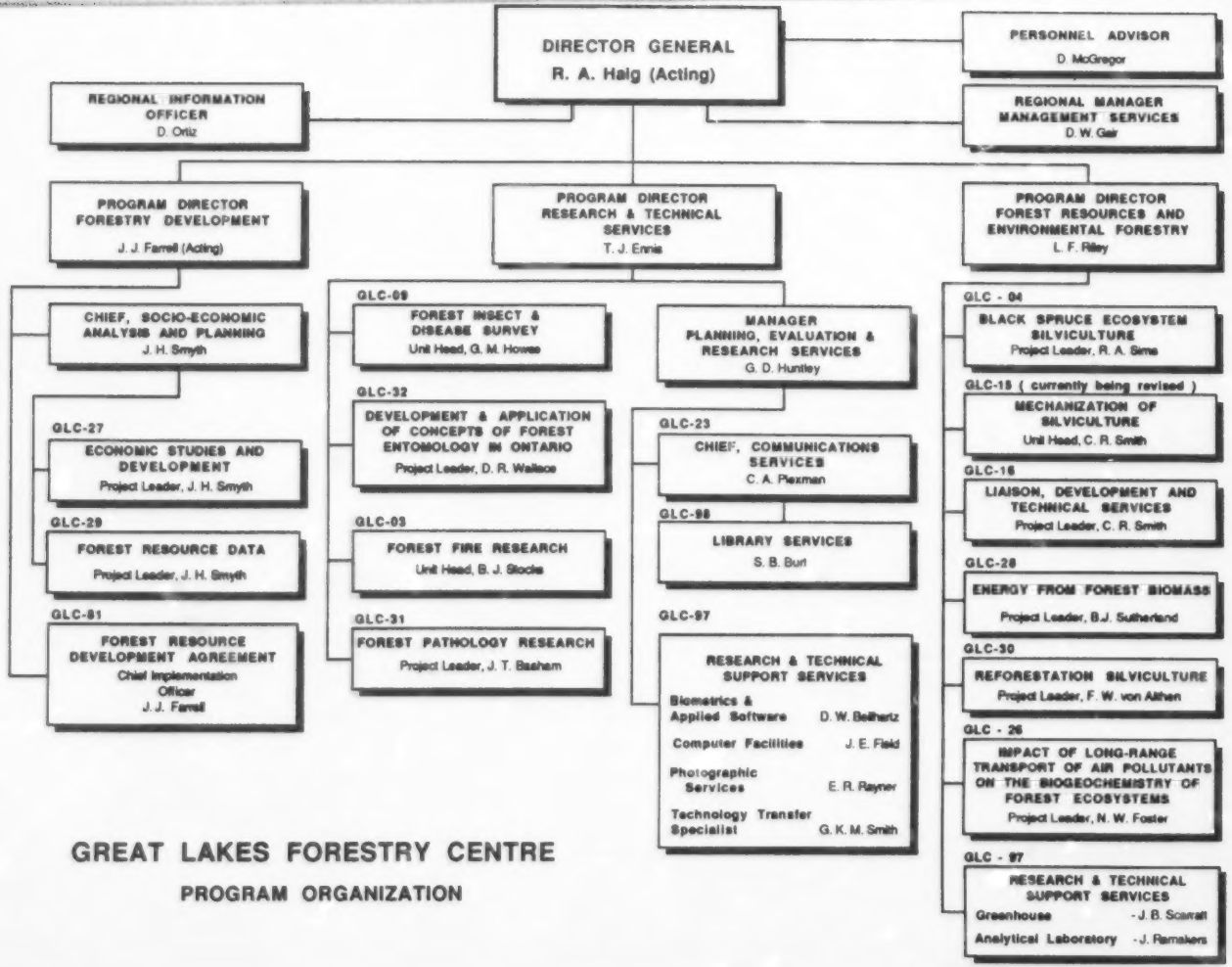
Achievements

Completed the classification course for specialists; coordinated the classification program with the CFS branch specialist; provided staffing and staff relations advice and service; administered the summer student program; instituted human resources planning, using the personnel management planning and employment equity approaches; conducted an annual training plan exercise that set priorities and cost estimates for regional training requirements; provided advice and guidance to management.

Goals for 1988-1989

To continue to provide personnel administration services to management in the areas listed above; to provide advice and guidance to managers on all aspects of personnel.

APPENDICES



GREAT LAKES FORESTRY CENTRE

PROGRAM ORGANIZATION

EXPENDITURES ($ '000) - 1987-1988

Project	Person Years	Salaries	Operations & Maintenance	Capital	Grants & Contributions	Other Operations & Maintenance	Total
Forest Environment Research							
Impact of Long-range Transport of Air Pollutants on the Biogeochemistry of Forest Ecosystems	9.8	415.0	116.1	29.4			560.5
Forest Production Research							
Black Spruce Ecosystem Silviculture	11.0	445.0	52.8	32.4			530.2
Mechanization of Silviculture	4.4	170.5	29.8	2.6			202.9
Reforestation Silviculture	10.9	465.0	42.5	3.5			511.0
Forest Protection Research							
Forest Fire Research	6.0	227.1	41.0	2.2			270.3
Forest Pathology Research	7.2	313.9	41.2	30.2			385.3
Development and Application of Concepts in Forest Entomology in Ontario	12.0	506.6	90.0	198.0			794.6
Forest Utilization Research							
Energy from Forest Biomass	0.1	4.4	49.7	5.3			59.4
Forestry Services							
Forest Insect and Disease Survey	26.0	929.7	125.8	9.0			1,064.5
Forestry Sector Data	1.5	57.8	4.0				61.8
Liaison, Development and Technical Services	1.6	55.4	8.3	0.6			64.3
Forestry Development							
Economics Studies and Development	3.5	149.9	11.5				161.4
Forest Resource Development Agreement	7.0	362.4		20.0	17,681.1	1,281.0	19,344.5
		98.3					122.3
Management	13.0	457.8	82.2				540.0
Administration, Financial Services and Physical Plant	39.0	1,405.4	1,225.7	381.7			3,012.8
Communications Services	6.0	163.1	113.0	0.3			276.4
Research Support Services	8.0	282.3	125.7	66.8			474.8
Personnel	0.0	0.0	3.5	0.0			3.5
COSEP & COOP		288.1	0.2				288.3
TOTALS	167.0	6,699.4	2,163.0	782.0	17,681.1	1,281.0	28,606.5

CONTRACTS LET BY THE GREAT LAKES FORESTRY CENTRE FOR THE YEAR 1987-1988

CONTRACTOR	CONTRACT TITLE	VALUE ($)	PAID 1987-1988 ($)
G.M. Wickware and Associates Burlington, Ontario	Conservation Soil Management for Intensively-managed Conifer Plantations	16,270.00	16,270.00
Art Jalkanen Nipigon, Ontario	Collection of Soil and Water Samples - Nipigon	3,020.00	3,020.00
David Ip Sault Ste. Marie Ontario	Investigate the Impact of Increase in Rain Acidity on Tree Diseases: Treatment on Trees and Data Collection and Analysis	6,762.00	6,762.00
John Berry Edmonton, Alberta	Effects of Forest Drainage on the Hydrology of Black Spruce Swamp and Low Ground Sites (Energy, Mines and Resources)	75,993.00	75,993.00
NRC, Ottawa, Ontario	Spruce Budworm Sex Pheromone Analysis	2,400.00	2,400.00

CANADA-ONTARIO FOREST RESOURCE DEVELOPMENT AGREEMENT CONTRACTS AND AGREEMENTS

Horton Forestry Services Richmond Hill, Ontario (COFRDA 33001)	Examination of Stand Structure and Development in Second-growth Black Spruce Forests	144,119.00	35,893.00
M. Browning Sault Ste. Marie Ontario (COFRDA 33002)	Mycorrhiza Development in Container Seedlings	221,075.00	60,381.00

(cont'd)

CONTRACTOR	CONTRACT TITLE	VALUE ($)	PAID 1987-1988 ($)
Hunter and Associates Toronto, Ontario (COFRDA 33003)	Fuel Complex Quantification in Natural Forested Stands in Northern Ontario	125,763.00	70,000.00
Prof. E.B. Dumbroff University of Waterloo (COFRDA 33004)	Drought Tolerance and Physiological Mechanisms of Resistance in Northern Coniferous Seedlings	124,597.00	38,290.00
ABL Forest Science Inc. Toronto, Ontario (COFRDA 33005)	Investigate Planting Stock Quality and Study the Adaptation of Conifer Seedlings to Site	153,123.00	36,233.00
Matcam Forestry Consultants, Inc. Sault Ste. Marie, Ontario (COFRDA 33006)	Direct Seeding of Black Spruce on Upland Sites in Northwestern Ontario	150,078.00	51,693.00
Dr. D.N. Roy Faculty of Forestry University of Toronto Toronto, Ontario (COFRDA 33007)	Chemical Characterization of Jack Pine as a Contribution to Developing Genetic Selection Criteria for Improving Fibre Production	87,332.00	46,016.00
Prof. D. Martell Faculty of Forestry University of Toronto Toronto, Ontario (COFRDA 33008)	The Impact of Fire on Timber Supply	134,917.00	40,685.00
Prof. F.C. Lozano Faculty of Forestry University of Toronto Toronto, Ontario (COFRDA 33009)	Calibrating Soil Nutrient Standards for Seed Orchard Management	163,205.00	40,861.00

(cont'd)

CONTRACTOR	CONTRACT TITLE	VALUE ($)	PAID 1987-1988 ($)
kbm Forestry Consultants Thunder Bay, Ontario (COFRDA 33010)	Investigation of the Effects of Microsite Compaction on Direct Seeding Success of Jack Pine and Black Spruce in Northwestern Ontario	46,621.00	14,342.00
Prof. R. Kreutzwiser Dept. of Geography University of Guelph Guelph, Ontario (COFRDA 33011)	Factors Influencing Integrated Forest Management on Private Industrial Forest Land	6,817.00	1,586.00
Prof. A.M. Gordon Dept. of Env. Biol. University of Guelph Guelph, Ontario (COFRDA 33012)	Post-harvesting Silvicultural Techniques to Enhance the White Pine and Red Oak Components in Shallow Site Forests in Central Ontario	45,687.00	8,039.00
Prof. G. Hofstra Dept. of Env. Biol. University of Guelph Guelph, Ontario (COFRDA 33013)	Reducing Drought and Temperature Stress in Conifer Seedlings With Sterol-inhibiting Growth Regulators	99,782.00	25,107.00
Dr. R.S. Jeng Faculty of Forestry Univ. of Toronto Toronto, Ontario (COFRDA 33014)	Mechanism of Stimulatory Effect of Linoleic Acid on Synnemata Formation by *Ophiostoma ulmi*	150,400.00	46,957.00
Pro-Vision Communications Group Ltd. Toronto, Ontario (COFRDA 33015)	Root Rot Technology Transfer	144,300.00	85,976.00

(cont'd)

CONTRACTOR	CONTRACT TITLE	VALUE ($)	PAID 1987-1988 ($)
E.B. Eddy Forest Products Limited Espanola, Ontario (COFRDA 33016)	Design and Implementation of Plantation Establishment Trials for Tamarack, with Particular Emphasis on Site Selection, Planting Stock and Herbicide Application	83,522.00	11,190.00
C. Nozzlillo Dept. of Biology University of Ottawa Ottawa, Ontario (COFRDA 33017)	Seed Development in Jack Pine (*Pinus banksiana* Lamb.)	56,240.00	29,081.00
Matcam Forestry Consultants Inc. Sault Ste. Marie, Ontario (COFRDA 33018)	Identification and Assessment of Fire Protection Programs for Intensively Managed Plantations	142,361.00	81,660.00
Prof. R.E. Farmer Jr. School of Forestry Lakehead University Thunder Bay, Ontario (COFRDA 33020)	Development of Short Rotation Silvicultural Systems for Selected Poplar and Larch in Northwestern Ontario	193,616.00	59,892.00
Hunter and Associates Toronto, Ontario (COFRDA 33022)	Forest Ecosystem Classification North Central Region, Ontario	87,584.00	28,050.00
Virve Manniste-Squire Sault Ste. Marie, Ontario (COFRDA 33023A)	Quantification of Glyphosate Breakdown Products in Off-target Deposit Samples from Drift Trials	48,148.00	43,433.00

(cont'd)

CONTRACTOR	CONTRACT TITLE	VALUE ($)	PAID 1987-1988 ($)
Drs. R.A. Fletcher and G. Hofstra Dept. of Env. Biol. University of Guelph Guelph, Ontario (COFRDA 33023B)	Measurement of Phytotoxicity of Sub-lethal Glyphosate Deposits on Selected Forest and Riparian Weed Species	48,480.00	29,392.00
Prof. R.J. Day School of Forestry Lakehead University Thunder Bay, Ontario (COFRDA 33024)	Establishment and Early Growth of Black Spruce (*Picea mariana* [Mill.] B.S.P.) in Relation to Seedling Physiology at Time of Outplanting	79,124.00	47,582.00
Ecological Services for Planning Limited Guelph, Ontario (COFRDA 33027)	Development of a Model to Predict the Timing and Impacts of Aerial Herbicide Spraying on Black Spruce in the Great Clay Belt	102,912.00	33,699.00
Ontario Centre for Remote Sensing Toronto, Ontario (COFRDA 33028)	Development of Operational Regeneration Assessment Methodology Based on High-resolution Satellite Data	123,371.00	50,000.00
John Berry Sault Ste. Marie, Ontario (COFRDA 33029)	Effects of Frost Drainage on the Hydrology of Black Spruce Swamp and Low Ground Sites	145,228.00	50,000.00
David Basham Sault Ste. Marie, Ontario (COFRDA 33C31)	Development of a Microcomputer Version of the Model "PLANT": Description of its Usage and Demonstration of its Application to the Forest Managers Involved in Forest Renewal Activities in Ontario	64,626.00	17,626.00
Wickware and Associates Burlington, Ontario (COFRDA 33C38)	Development of a Soils-Landform Course, North Central Region, Ontario	24,500.00	11,750.00

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